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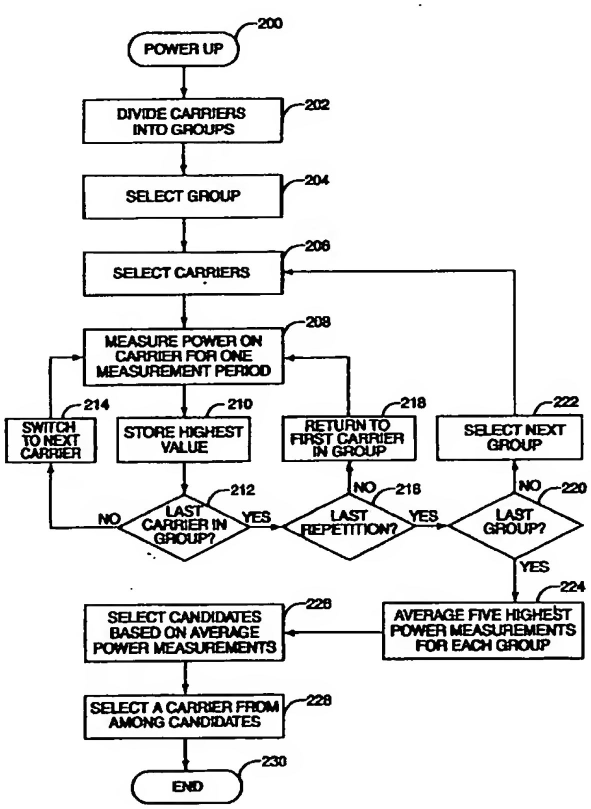
(54) Title: CHANNEL SELECTION METHOD



(57) Abstract: A channel selection method is implemented by a mobile terminal in a time division multiple access system. The mobile terminal performs a plurality of power measurements on a plurality of carriers over a plurality of measurement periods on each carrier. The measurement periods on each carrier are spaced at predetermined intervals of time and are interleaved with the measurement periods on other ones of the carriers. The mobile terminal selected a channel based on the power measurements.

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CHANNEL SELECTION METHOD

RELATED APPLICATIONS

The present application claims the benefit of U.S. Provisional Patent Application 60/162,903, filed 2 November 1999, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

The present invention relates in general to mobile wireless communication systems, and more particularly, to a channel selection method for such systems.

Enhanced Data Rates for Global Evolution (EDGE) is an evolution of the Global System for Mobile Communications (GSM) standard and the Telecommunications Industry Association (TIA)/Electronic Industry Association (EIA) standard TIA/EIA-136 for Time Division Multiple Access (TDMA) systems that allows high rate packet data capability. There are two modes in which EDGE can be deployed, EDGE Classic, which is similar to the way EDGE is deployed in GSM systems, and an enhanced mode called EDGE Compact. EDGE Compact requires less than 1 MHz of spectrum for deployment while EDGE Classic requires 2.4 MHz of spectrum. In either case, when a mobile terminal is switched on, it is important for it to obtain service as soon as possible. For this to happen, the mobile terminal needs to read the broadcast information transmitted by the system, following which it can make a random access and register with the system. This process is described in the GSM specification GSM 05.08, published by the European Telecommunications Standards Institute (ETSI), which deals with Radio Subsystem Link Control.

In EDGE Classic, carriers with broadcast and common control information, called BCCH carriers, are transmitted continuously with constant power, whereas

other carriers may have power variations and power off conditions at different times. Thus, the channel selection procedure specified in GSM 05.08 requires the mobile terminal to do the following:

1. Measure power on all carriers;
2. Average at least five of these measurements over a range of 3-5 seconds;
3. Choose the carriers with the highest average power as candidates to search for control channels.

However, the channel selection procedure described in GSM 05.08 is not appropriate for EDGE Compact since the carriers with the broadcast information have discontinuous transmission. Only the time slots with control information are required to be transmitted at maximum power, and the rest of the time slots can transmit with less than maximum power or may be idle. Thus, measurements of signal strength have to be modified in order to make sure that a sufficient number of valid measurements are obtained, or new methods that do not rely on the such power measurements need to be defined.

BRIEF SUMMARY OF THE INVENTION

The present invention relates to a channel selection method implemented by a mobile terminal in a time division multiple access (TDMA) system. At power up, the mobile terminal attempts to find a channel on which to acquire service by performing a series of power measurements. In conventional TDMA systems, the mobile terminal performs a series of power measurements on the available carriers to find one or more control channels, and then selects a channel on which to acquire service. In EDGE Compact systems the control channel is not transmitted continuously so the method of performing power measurements needs to take the discontinuous transmission of control

information into account . The present invention provides a channel selection method particularly adapted for a system that transmits control information discontinuously.

According to the present invention, the mobile terminal performs a plurality of power measurements on a plurality of carriers over a plurality of measurement periods on each carrier. The measurement periods on each carrier are spaced at predetermined intervals of time and are interleaved with the measurement periods on other ones of the carriers in a manner to reduce the amount of time needed to select a channel. More particularly, the mobile terminal divides the available carriers into a plurality of groups of carriers. For each group, the mobile terminal performs power measurements on each carrier in sequence. The power measurements are repeated a predetermined number of times on each carrier. More particularly, the mobile terminal selects a carrier, performs power measurements over a predetermined measurement period, stores the highest value obtained during the measurement period, and then changes to the next carrier in the group. The mobile terminal repeats this process for each carrier within the group to complete one measurement cycle. The measurement cycle is then repeated until a predetermined number of valid power measurements are obtained for each carrier in the group.

After performing the power measurements as described above, the mobile terminal averages the five highest power measurements for each carrier to obtain an average power for each carrier. The mobile terminal then selects a plurality of candidate carriers by choosing those with the highest average power. Once the candidate carriers are identified, the mobile terminal selects one of the candidate carriers on which to acquire service, synchronizes to the selected channel, reads the information on the broadcast control channel, and then registers with the network.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a network diagram illustrating an exemplary wireless communications system.

Figure 2 is a cell plan for the exemplary wireless communications system of Figure 1.

Figure 3 is a diagram illustrating the frame structure used by the exemplary wireless communications system of Figure 1.

Figures 4A-4D are diagrams illustrating the frequency and time reuse plan implemented by the exemplary wireless communications system of Figure 1.

Figures 5A-5C are diagrams illustrating how the power measurements in one illustrative embodiment are interleaved.

Figure 6 is a block diagram of an exemplary mobile terminal that implements the channel selection method of the present invention.

Figure 7 is a flow chart illustrating the channel selection procedure according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is described in the context of a wireless communications system 10 shown schematically in Figure 1. The wireless communications system 10 implements the Global System for Mobile Communications (GSM) standard published by the European Telecommunications Standards Institute (ETSI). More particularly, the wireless communications system 10 implements the variant of GSM known as Enhanced Data Rates for Global Evolution (EDGE) Compact. Those skilled in the art will appreciate, however, that the present invention may be used for other types of wireless communication systems and access protocols, such as the Telecommunications Industry Association/ Electronics Industry Association (TIA/EIA) standard TIA/EIA-136.

The wireless communications system 10 comprises a plurality of mobile terminals 100 and base stations 12, and one or more mobile switching centers (MSCs) 14. Each base station 12 is located in and provides services to a geographic region referred to as a cell. In general, there is one base station 12 for each cell within a given wireless communications system 10. Within each cell, there may be a plurality of mobile terminals 100 that communicate via radio link with the serving base station 12. Base stations 12 connect via one or more MSCs 14 to external wireline networks 18 such as the Public Switched Telephone Network (PSTN), the Integrated Services Digital Network (ISDN), and/or the Internet. At least one MSC 14 may serve as a gateway to the external wireline network 18 or to other Public Land Mobile Networks (PLMNs). The MSC 14 routes calls to and from the mobile terminal 100 through the appropriate base station 12 or gateway.

Figure 2 is a cell plan for the wireless communications system 10 implementing the EDGE Compact standard which employs time and frequency reuse. Each cell comprises three sectors (represented as hexagons in Figure 2), which are typically served by a single base station 12. Each base station 12 is allocated at least three carrier frequency groups; one for each sector. The carrier frequency groups are reused in each sector using a 1/3 frequency reuse pattern as shown in Figure 2. The carrier frequency groups may comprise one or more carrier frequencies.

Each carrier frequency is subdivided into frames, and each frame is further subdivided into eight time slots, as shown in Figure 3. The frames are approximately 4.6 ms in length. The time slots are approximately .577 ms in length. Selected time slots in selected frames are used as control channels to transmit and receive packet control signaling while the remaining time slots serve as traffic channels to transmit and receive user data, i.e., voice or packet data.

Base station timing for all bases stations 12 is synchronized so that all base stations 12 use the same frame and hyper-frame timing. Inter base station

synchronization makes it possible to create time groups. Time groups are used to create a time reuse pattern on top of the frequency reuse pattern to create a higher effective reuse for certain control channels. Time groups are not typically employed for traffic channels.

In the exemplary embodiment described herein, four time groups are defined but one may chose not to use all of them. Each sector is assigned to one time group. The time groups are arranged in a 1/4 reuse pattern, as shown in Figure 2. To avoid adjacent channel interference, adjacent sectors are assigned to different time groups.

Within each time group, selected time slots in selected frames are used to transmit packet control signaling as shown in Figure 3. The time slots chosen for packet control signaling in each time group are different. For example, time group 1 may use slot 1 for packet control signaling, time group 2 may use slot 3, time group 3 may use slot 5, and time group 4 may use slot 7. In blocks when one sector belonging to one time group transmits or receives packet control signaling, the sectors belonging to the other time groups are idle, i.e. are silent on both the uplink and downlink. The superimposition of the time reuse pattern on top of the frequency reuse pattern creates a higher effective reuse pattern for packet control signaling.

Figures 4A-4D illustrates the EDGE Compact Frame Structure, which is used in the exemplary embodiment described herein. The frame structure is based on a matrix with 52 rows and 8 columns, where columns represent time slots and rows represent succeeding frames in a 52-frame multiframe. Time slot mapping is carried out such that broadcast channel (BCCH), common control channel (CCCH), Frequency Correction Channel (FCCH), and Synchronization Channel (SCH) of a certain time group rotate their time slot position over odd-numbered time slots. Only the FCCH, SCH, BCCH and CCCH rotate their time slot position from one multiframe to the next. The traffic channels do not rotate their time slot position. The rotation occurs once a multiframe between

frames 4 and 5. The pattern of rotation will therefore repeat itself every four multiframes creating a 208 multiframe pattern. If the sequence number of a 52-frame multiframe is denoted as N, then the four different rotation possibilities (0,1,2, and 3) is given as N MOD 4.

The rotation patterns for all four time groups are offset so that at any given time each time group employs a different rotation as shown in Figure 4. Thus, in blocks where time group 1 is transmitting packet control signaling, time groups 2, 3 and 4 are idle. Similarly, in blocks where time group 2 is transmitting packet control signaling, time groups 1, 3 and 4 are idle; in blocks where time group 3 is transmitting packet control signaling, time groups 1, 2 and 4 are idle; and in blocks where time group 4 is transmitting packet control signaling, time groups 1, 2 and 3 are idle. The multiframe structure for EDGE Compact is described in greater detail in "Concept Proposal for GPRS-136HS EDGE, Revision 1.4" presented to the European Telecommunications Institute (ETSI) in September 1999.

As seen in Figure 4, time group 1 transmits the BCCH in time slot 1 during rotation 1. Time group 2 transmits the BCCH during time slot 3, time group 3 transmits the BCCH during time slot 5, and time group 4 transmits the BCCH during time slot 7. During the next multiframe or rotation, each time group shifts its transmit slot two slots right so that time group 1 transmits the BCCH on time slot 3. Time groups 2 and 3 likewise shift right by two time slots. Time group 4 rotates circularly from time slot 7 to time slot 1. This rotation occurs each multiframe and repeats every four multiframes.

In conventional wireless communications systems, carriers with broadcast and control channel information are broadcast continuously with constant power. At power-up, the mobile terminal 100 can locate a control channel by performing power measurements on the available carriers and selecting as candidates those with the highest power levels. In EDGE Compact systems, however, packet control signaling is

not transmitted continuously. Instead, packet control signaling is transmitted in selected time slots on carriers that also carry traffic. While certain control channels are transmitted at constant power, which is typically maximum power, the power level on the traffic channel is constantly varying. For purposes of further explanation, the control channels transmitted at constant power are referred to herein as power reference channels. The power reference channels in the exemplary embodiment comprise the BCCH, CCCH, SCH, or FCCH.

The discontinuous transmission of packet control signaling makes power measurement during a power-up more difficult. If a power measurement is made over a short period of time, for example a few frames, there is no guarantee that the measurement would be at a time when the base station is transmitting at maximum power (i.e., during a BCCH, CCCH, SCH, or FCCH). The mobile terminal 100 could perform a series of power measurements over a period of about twenty frames, in which case the mobile terminal 100 would be assured of obtaining at least one valid power measurement of a power reference channel. This method, however, would require a relatively long period of time to complete, particularly if there are a large number of available channels. The present invention provides a method of performing power measurements in a more time efficient manner so that the mobile terminal 100 can select a channel and acquire service with the wireless communications system 10 more quickly.

According to the present invention, the mobile terminal 100 performs power measurements on each carrier in one or more frequency bands of interest. First, the mobile terminal 100 divides the total number of carriers, denoted as N_t, into groups of N_c carriers. Note that the number of carriers in a group need not divide evenly into the total number of carriers. Some or all groups may use dummy carriers if that group has less than N_c carriers. Alternatively, some carriers may be included in more than one group to ensure that each group has N_c carriers. Moreover, all carriers could be assigned to a

single group. Second, after dividing the carriers into groups, the mobile terminal 100 performs a sequence of power measurements in a manner described below to ensure that a predetermined number of valid power measurements are obtained for each carrier. A valid power measurement is one which is obtained while a power reference channel (e.g., BCCH, CCCH) is being transmitted. Third, after obtaining power measurements for all carrier frequencies in all groups, the mobile terminal 100 averages a selected number of the power measurements with the highest values to obtain an average maximum power value for each carrier frequency. Fourth, a selected number of the carrier frequencies are selected as candidate carriers. The selected carriers are those with the highest average maximum power value.

To perform the power measurements within each carrier group, the mobile terminal 100 of the present invention interleaves the power measurements on a plurality of carriers in a manner to lessen the time needed to complete the power measurements. Instead of making continuous power measurements on each frequency for a sufficient time to ensure one valid measurement, the mobile terminal 100 of the present invention performs measurements over a plurality of time intervals which are spaced from one another. More particularly, the mobile terminal 100 will lock on and perform multiple power measurements in a fixed interval of time, referred to herein as the measurement period T_m, on each carrier. The maximum of these power measurements taken over the measurement period T_m is stored. This process is repeated for each carrier frequency within the carrier group to complete one cycle. After going through all N_c carriers in the group, i.e., one cycle, the mobile terminal 100 returns to the first carrier and repeats the power measurements for each carrier in the group. The mobile terminal 100 repeats the power measurements on each carrier a predetermined number of times to ensure at least five valid power measurements. The number of carriers in each group N_C, the

measurement period T_m, and the number of repetitions k on each carrier are chosen to minimize the time needed to obtain the desired number of valid power measurements.

Figures 5A-5C illustrate one example of the channel selection method according to the present invention. The example in Figures 5A-5C is suitable for use in the EDGE Compact system of Figures 1 and 2. EDGE Compact employs three carrier frequencies. Thus, the total number of available carriers, N_t, is three. In this example, only one carrier group is needed so that N_c is also equal to three. Figures 5A-5C show a multiframe for each of the three carrier frequencies. The shaded time slots in Figures 5A-5C represent the measurements periods T_m during which power measurements are taken on each carrier. In this example, the measurement period T_m is equal to nine time slots. One time slot is needed for the frequency synthesizer to settle on the desired frequency so that power measurements are actually taken over eight time slots. The spacing between measurement periods in this example is $(N_c-1)x9$ which equals eighteen time slots. By interleaving power measurements on the different frequencies, the present invention significantly reduces the time needed to obtain the desired number (in this case, the desired number is 5) of power measurements.

By way of further example, assume that the total number of carrier frequencies N_t is equal to 967. Assuming that the measurement period T_m is nine time slots as before, two possible values for the number of carriers per group N_c (out of many) are 53 and 967. For these values of N_c, eighteen measurement periods for each carrier frequency are needed to ensure five valid power measurements. With N_c equal to 967 or N_c equal to 53, the total measurement time to obtain five valid power measurements was found to be 90.37 seconds.

When the value of N_c is large, as in the last example, consecutive power measurements on the same carrier will not occur in the same frame. However, consecutive measurement periods will occur at different locations in the multiframe. The

spacing between measurement periods depends on the number of carriers within a group N_c, and the length of the measurement period T_m, which can be chosen to minimize the time needed to acquire the measurements. Values for N_c and the measurement period T_m can be determined by means of a computer simulation which computes the total measurement time based on different values of N_c and T_m.

Figure 6 is a block diagram of an exemplary typical mobile terminal 100 that implements the channel selection method of the present invention. As used herein, the term mobile terminal 100 means any device capable of wireless communications. A mobile terminal 100 may, for example comprise a cellular radiotelephone, a personal communications terminal that combines a cellular radiotelephone with data processing capabilities, such as a Personal Communication System (PCS) device or Personal Digital Assistant (PDA), or a portable computing device, such as laptop computer or palmtop computer, equipped with a radiotelephone. Mobile terminals 100 may also be referred to as "pervasive computing" devices.

The mobile terminal 100 includes a main control unit 102 for controlling the operation of the mobile terminal 100 and a memory 104 for storing control programs and data used by the mobile terminal 100 during operation. Input/output circuits 106 interface the main control unit 102 with a keypad 108 or other user input device, display 110, audio processing circuits 112, receiver 120, and transmitter 122. The keypad 108 allows the operator to dial numbers, enter commands, and select options. The display 110 allows the operator to see dialed digits, stored information, and call status information. The audio processing circuits 112 provide basic analog audio outputs to a speaker 114 and accept analog audio inputs from a microphone 116. The receiver 120 and transmitter 122 receive and transmit signals using shared antenna 124. Digital signal processing (DSP) circuits 126 process signals transmitted and received by the mobile terminal 100. The DSP circuits 126 include power measurement circuits to determine the power of signals

received by the mobile terminal 100. The mobile terminal 100 may further comprise a GPS receiver 130 or other type of positioning receiver. The GPS receiver 130 enables the mobile terminal 100 to determine its current location based on positioning signals transmitted by a GPS satellite. In the disclosed embodiment, the GPS receiver 130 includes a separate antenna 132, however, the GPS receiver 130, the receiver 120, and transmitter 122 could use a shared antenna.

The main control unit 102 implements the communication protocols used by the mobile terminal 100. The communication protocol specifies timing, multiple access approach, modulation format, frame structure, power level, as well as many other aspects of mobile terminal operation. The main control unit 102 inserts signaling messages into the transmitted signals and extracts signaling messages from the received signals. Main control unit 102 acts on signaling messages received from the base station 12 as set forth in the communication protocol.

Figure 7 is a flow chart illustrating an exemplary channel selection procedure according to the present invention implemented by the main control unit 102. The channel selection procedure of Figure 7 begins when the mobile terminal 100 is powered on (block 200). The purpose of the channel selection procedure is to enable the mobile terminal to locate a channel on which to acquire service. After powering on (block 200), the mobile terminal 100 divides the available carriers into groups of N_c carriers per group (block 202). The mobile terminal 100 then selects a first group of carriers (block 204) and a first carrier in the selected group (block 206) to begin performing power measurements. At block 208, the mobile terminal 100 measures power on the selected carrier beginning with the first carrier in the selected group. The power measurement is performed over a predetermined interval of time T_m, which in the exemplary embodiment is equal to nine time slots (which includes the time needed to switch to the carrier). A plurality of time measurements are made during the measurement period T_m and the highest

measurement obtained during the measurement period T_m is stored (block 210). After performing the power measurements in step 208, the mobile terminal 100 determines whether it has reached the last carrier in the group (block 212). If not, the mobile terminal 100 switches to the next carrier in the group (block 214) and performs power measurements on the newly selected carrier (block 208). This process repeats until the last carrier in the group is reached. Once the last carrier in the group is reached, the mobile terminal 100 determines whether the specified number of repetitions has been completed (block 216). If not, the mobile terminal 100 returns to the first carrier in the group (block 218) and repeats the power measurements on each carrier. Decision block 216 ensures that the mobile terminal 100 repeats the power measurements on each carrier in the group a predetermined number of times. The number of repetitions is chosen to ensure at least five (or some other specified number) valid power measurements of a power reference channel on each carrier. After completing the specified number of repetitions for a group, the mobile terminal 100 then determines whether the currently-selected group is the last group (block 220). If not, the mobile terminal 100 selects the next group of carriers (block 222). The mobile terminal 100 selects an initial carrier in the newly selected group (block 206) and begins performing power measurements (block 208). The mobile terminal 100 repeats the power measurements (block 208) on each carrier in the newly selected group until the final carrier in the final group is reached.

Once the mobile terminal 100 completes the power measurements on all carriers in all groups, the mobile terminal 100 then averages a specified number (e.g., five) of the highest power measurements for each carrier to obtain an average power for each carrier (block 224). This is done for the purpose of alleviating Rayleigh fading effects, which are common in radio channels. By averaging power values spaced in time, the fading effects

are averaged out. The mobile terminal 100 then selects one or more candidate carriers (block 226) based on the average power of the carriers.

Eventually, the mobile terminal 100 selects one carrier from among the candidate carriers on which to acquire service (block 228). The details of how the final selection is made are well known in the art and are not material to the present invention. The final selection criteria is typically dependent upon the particular service provider. In general, the service provider programs the mobile terminal 100 to select those carriers which it most prefers from among the available candidate carriers. If one of the carriers is the home carrier for the mobile terminal 100, that carrier will typically be selected provided that quality of service requirements are met. The remaining carriers are divided into classes based on the preference of the service provider.

Once a carrier is selected, the mobile terminal 100 attempts to acquire service on the carrier. The mobile terminal 100 typically locks on to the Frequency Correction Channel (FCH) to obtain coarse information about timing and frequency offset. It then locks on the Synchronization Channel (SCH), which occurs at a fixed time offset away from the FCH, and obtains information regarding the position of the BCCH. It then reads the BCCH and is ready to register to the system. After registering, the mobile terminal 100 enters the camping state on the selected control channel. The channel selection procedure terminates when the mobile terminal enters the camping state on a selected carrier (block 230).

The present invention may, of course, be carried out in other specific ways than those herein set forth without departing from the scope and essential characteristics of the invention. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

CLAIMS

What is claimed is:

1. A channel selection method implemented by a mobile terminal in a mobile communication system, said method comprising:

performing a plurality of power measurements on a plurality of carriers over a plurality of measurement periods on each carrier, wherein said measurement periods on each carrier are spaced at predetermined intervals of time and are interleaved with said measurement periods on other ones of said carriers; and

selecting a channel based on said power measurements.

2. The method of claim 1 wherein performing said plurality of power measurements on said plurality of carriers over said plurality of measurement periods on each carrier comprises performing power measurements on said plurality of carriers in sequence during successive power measurement periods beginning with a first carrier in said sequence and ending with a last carrier in said sequence, and repeating said sequential power measurements a predetermined number of times for each carrier.

3. The method of claim 2 wherein performing power measurements on said plurality of carriers in sequence during successive power measurement periods beginning with a first carrier in said sequence and ending with a last carrier in said sequence comprises performing a plurality of measurements on each carrier in sequence over a fixed time interval and storing the highest value of said power measurements over said fixed interval on each carrier on each repetition.

4. The method of claim 3 wherein repeating said sequential power measurements a predetermined number of times for each carrier comprises repeating said sequential

power measurements a sufficient number of times to ensure that at least one measurement is made while a power reference channel is being transmitted.

5. The method of claim 1 wherein selecting a channel based on said power measurements comprises:

selecting a predetermined number of power measurements on each carrier;

averaging said selected power measurements on each carrier to obtain an average power for each carrier; and

selecting one or more candidate channels based on said average power measurements.

6. The method of claim 1 wherein said wireless communications system operates according to an EDGE Compact protocol.

7. A channel selection method implemented in a mobile terminal to select a carrier from a plurality of available carriers, said method comprising:

dividing said available carriers into groups of carriers, each group of carriers comprising a plurality of carriers;

for each group of carriers, performing a plurality of power measurements on said plurality of carriers in said group over a plurality of measurement periods, wherein said measurement periods on each carrier in said group are interleaved with said measurement periods on other ones of said carriers in said group; and

selecting a channel based on said power measurements.

8. The method of claim 7 wherein performing a plurality of power measurements on said plurality of carriers in said group over a plurality of measurement periods comprises performing power measurements on said plurality of carriers in sequence beginning with a first carrier in said group and ending with a last carrier in said group, and repeating said sequential power measurements a predetermined number of times for each carrier in said group.

9. The method of claim 8 wherein performing power measurements on said plurality of carriers in sequence beginning with said first carrier in said group and ending with said last carrier in said group comprises performing a series of measurements on each carrier in sequence over a fixed time interval and storing the highest value of said power measurements over said fixed interval on each carrier on each repetition.

10. The method of claim 9 wherein repeating said sequential power measurements said predetermined number of times for each carrier in said group comprises repeating said sequential power measurements a sufficient number of times to ensure that at least one power measurement is made while a power reference channel is being transmitted by a base station.

11. The method of claim 7 wherein selecting a channel based on said power measurements comprises:

selecting a predetermined number of power measurements on each carrier in each group of carriers;

averaging said selected power measurements on each carrier in each group of carriers to obtain an average power for each carrier; and

selecting one or more candidate channels based on said average power measurements.

12. The method of claim 7 wherein said wireless communications system operates according to an EDGE Compact protocol.

13. A method for synchronizing a mobile terminal in a wireless communication system, said method comprising:

determining a total number of available carriers;

dividing said total number of available carriers into groups of carriers such that each group comprises a plurality of carriers;

for each group of carriers,

performing a plurality of power measurements on each carrier in said group over a plurality of measurement periods, wherein said measurement periods on each carrier in said group are spaced at predetermined intervals of time and are interleaved with said measurement periods on other ones of said carriers in said group;

storing a maximum of said power measurements over each measurement period on each carrier in said group; and

selecting one or more candidate channels based on said power measurements.

14. The method of claim 13 wherein performing a plurality of power measurements on each carrier in said group over a plurality of measurement periods comprises performing a plurality of power measurements on each carrier in said group during each measurement period.

15. The method of claim 13 wherein said wireless communications system operates according to an EDGE Compact protocol.

16. A mobile terminal comprising:

a receiver to receive signals on a plurality of carriers;

a power measurement circuit operatively connected to said receiver to measure the power of signals received on said plurality of carriers, wherein said power measurement circuit performs a plurality of power measurements on said plurality of carriers over a plurality of measurement periods on each carrier, wherein said measurement periods on each carrier are spaced at predetermined intervals of time and are interleaved with the measurement periods on other ones of the said carriers; and

control logic to control the operation of said power measurement circuit and to select a channel based on said power measurements made by said power measurement circuit.

17. The mobile terminal according to claim 16 wherein said power measurement circuit performs said plurality of power measurements on said plurality of carriers sequentially during successive measurement periods beginning with a first carrier and ending with a last carrier, and repeats said sequential power measurements a predetermined number of times for each carrier.

18. The mobile terminal of claim 17 wherein said power measurement circuit performs said plurality of power measurements during each measurement period and stores the highest value of said power measurements over each of said measurement periods.

19. The mobile terminal of claim 18 wherein said control unit averages a selected number of power measurements on each carrier to obtain an average power for each carrier and selects one or more candidate channels based thereon.

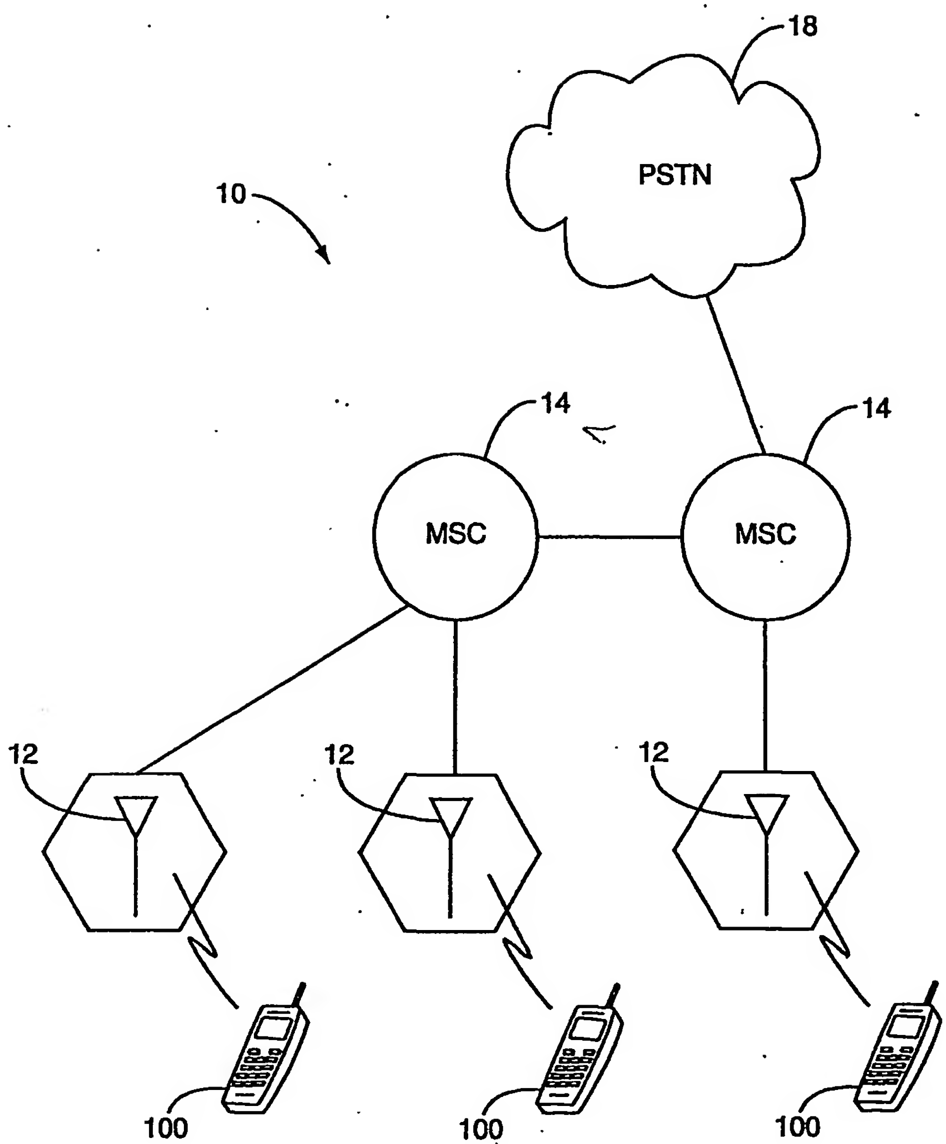
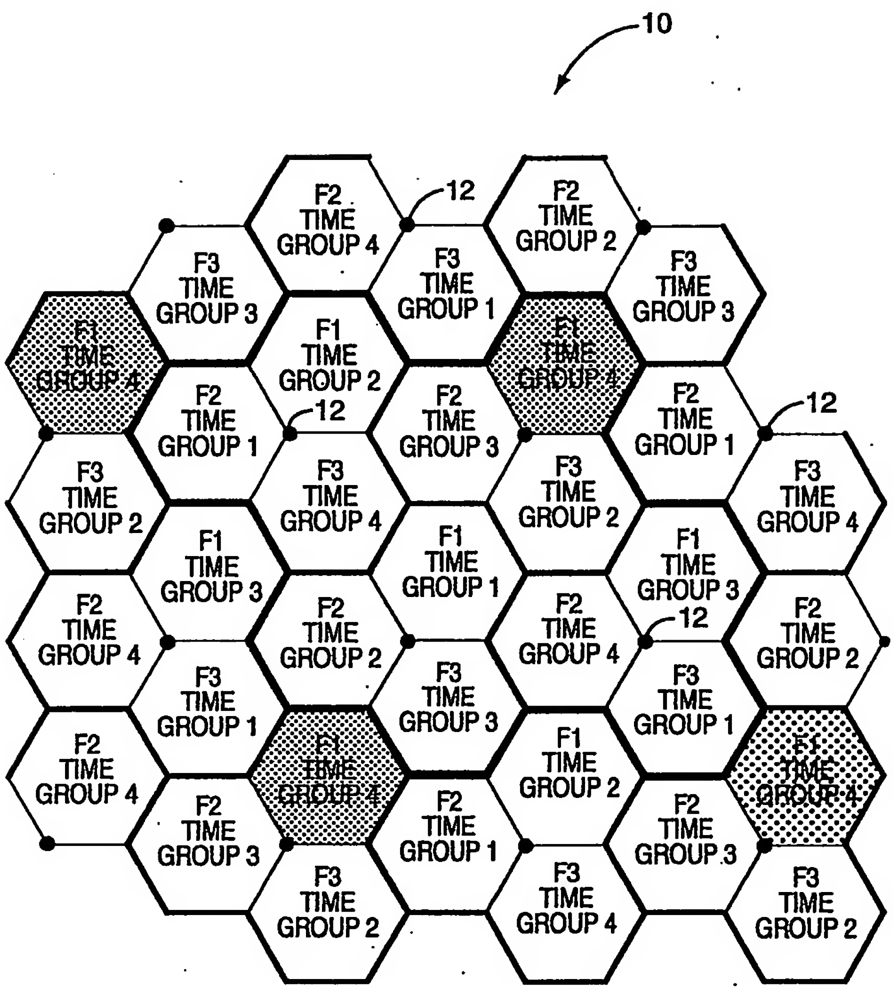


FIG. 1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F1 TIME GROUP 2
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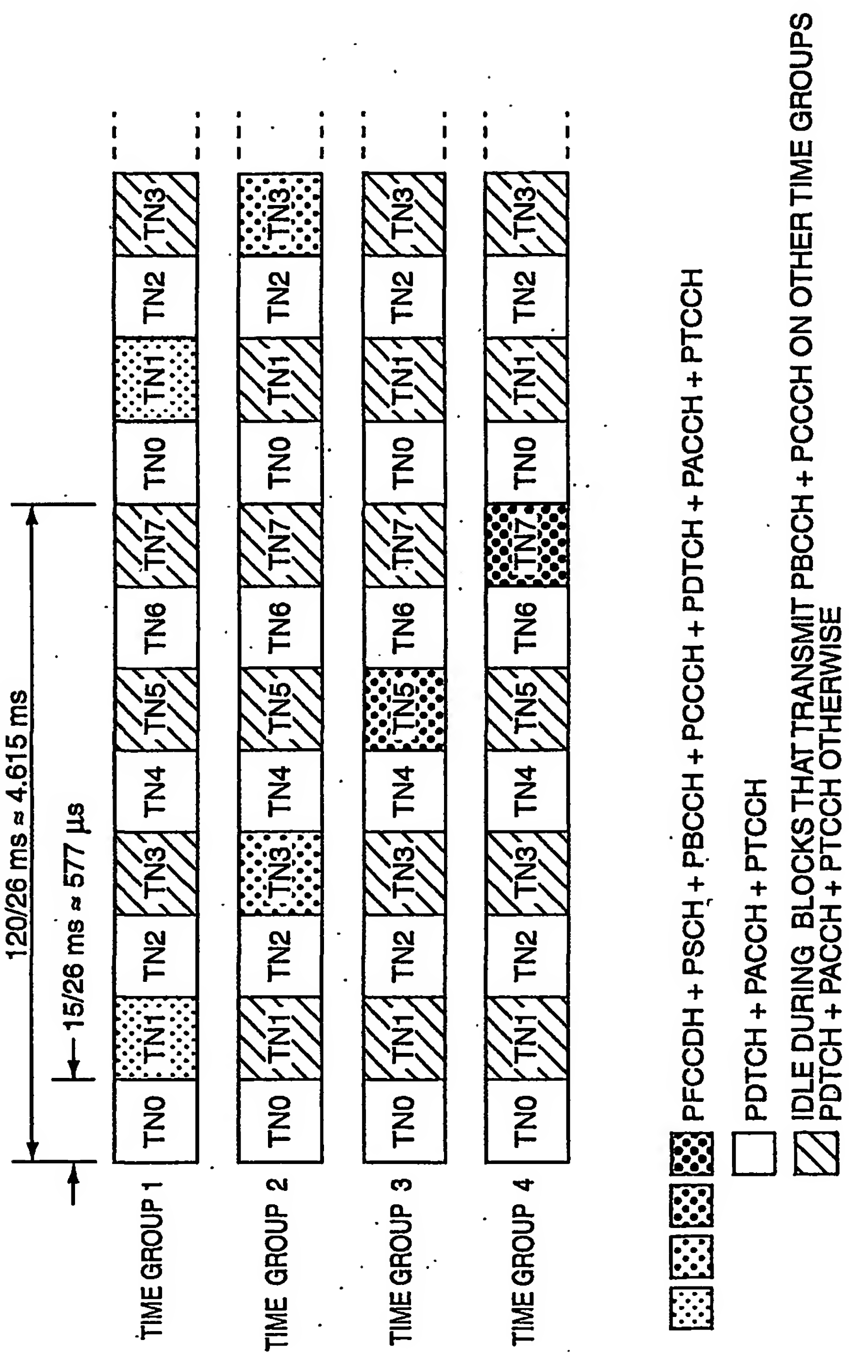
FIG. 2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TIME GROUP 2
TIME GROUP 3
TIME GROUP 4
TN0
TN1
TN2
TN3
TN4
TN5
TN6
TN7
PFCCDH + PSCH + PBCCH + PCCCH + PDTCH + PACCH + PTCCH
PDTCH + PACCH + PTCCH
IDLE DURING BLOCKS THAT TRANSMIT PBCCH + PCCCH ON OTHER TIME GROUPS
PDTCH + PACCH + PTCCH OTHERWISE

FIG. 3

FRAMES 0-51 OF A 208-MULTIFRAME
(N MOD 4 = 0)
TIME GROUP 1

TS FRAME	0	1	2	3	4	5	6	7
0		BCCH		IDLE		IDLE		IDLE
1		BCCH		IDLE		IDLE		IDLE
2		BCCH		IDLE		IDLE		IDLE
3		BCCH		IDLE		IDLE		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12	PTCCH							
13								
14								
15								
16								
17								
18								
19								
20								
21		IDLE		IDLE		IDLE		CCCH
22		IDLE		IDLE		IDLE		CCCH
23		IDLE		IDLE		IDLE		CCCH
24		IDLE		IDLE		IDLE		CCCH
25	IDLE							FCCH
26								
27								
28								
29								
30								
31								
32								
33								
34		IDLE		IDLE		IDLE		CCCH
35		IDLE		IDLE		IDLE		CCCH
36		IDLE		IDLE		IDLE		CCCH
37		IDLE		IDLE		IDLE		CCCH
38	PTCCH							
39								
40								
41								
42								
43								
44								
45								
46								
47		IDLE		IDLE		IDLE		CCCH
48		IDLE		IDLE		IDLE		CCCH
49		IDLE		IDLE		IDLE		CCCH
50		IDLE		IDLE		IDLE		CCCH
51	IDLE							SCH

FIG 4A

FRAMES 0-51 OF A 208-MULTIFRAME
(N MOD 4 = 0)
TIME GROUP 2

TS FRAME	0	1	2	3	4	5	6	7
0		IDLE		BCCH		IDLE		IDLE
1		IDLE		BCCH		IDLE		IDLE
2		IDLE		BCCH		IDLE		IDLE
3		IDLE		BCCH		IDLE		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12	PTCCH							
13								
14								
15								
16								
17								
18								
19								
20								
21		CCCH		IDLE		IDLE		IDLE
22		CCCH		IDLE		IDLE		IDLE
23		CCCH		IDLE		IDLE		IDLE
24		CCCH		IDLE		IDLE		IDLE
25	IDLE	FCCH	IDLE					
26								
27								
28								
29								
30								
31								
32								
33								
34		CCCH		IDLE		IDLE		IDLE
35		CCCH		IDLE		IDLE		IDLE
36		CCCH		IDLE		IDLE		IDLE
37		CCCH		IDLE		IDLE		IDLE
38	PTCCH							
39								
40								
41								
42								
43								
44								
45								
46								
47		CCCH		IDLE		IDLE		IDLE
48		CCCH		IDLE		IDLE		IDLE
49		CCCH		IDLE		IDLE		IDLE
50		CCCH		IDLE		IDLE		IDLE
51	IDLE	SCH	IDLE					

FIG 4B

FRAMES 0-51 OF A 208-MULTIFRAME
(N MOD 4 = 0)
TIME GROUP 3

TS FRAME	0	1	2	3	4	5	6	7
0		IDLE		IDLE		BCCH		IDLE
1		IDLE		IDLE		BCCH		IDLE
2		IDLE		IDLE		BCCH		IDLE
3		IDLE		IDLE		BCCH		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12				PTCCH				
13								
14								
15								
16								
17								
18								
19								
20								
21		IDLE		CCCH		IDLE		IDLE
22		IDLE		CCCH		IDLE		IDLE
23		IDLE		CCCH		IDLE		IDLE
24		IDLE		CCCH		IDLE		IDLE
25		IDLE		FCCH		IDLE		
26								
27								
28								
29								
30								
31								
32								
33								
34		IDLE		CCCH		IDLE		IDLE
35		IDLE		CCCH		IDLE		IDLE
36		IDLE		CCCH		IDLE		IDLE
37		IDLE		CCCH		IDLE		IDLE
38				PTCCH				
39								
40								
41								
42								
43								
44								
45								
46								
47		IDLE		CCCH		IDLE		IDLE
48		IDLE		CCCH		IDLE		IDLE
49		IDLE		CCCH		IDLE		IDLE
50		IDLE		CCCH		IDLE		IDLE
51		IDLE		SCH		IDLE		

FIG 4C

FRAMES 0-51 OF A 208-MULTIFRAME
(N MOD 4 = 0)
TIME GROUP 4

TS FRAME	0	1	2	3	4	5	6	7
0		IDLE		IDLE		IDLE		BCCH
1		IDLE		IDLE		IDLE		BCCH
2		IDLE		IDLE		IDLE		BCCH
3		IDLE		IDLE		IDLE		BCCH
4								
5								
6								
7								
8								
9								
10								
11								
12	PTCCH							
13								
14								
15								
16								
17								
18								
19								
20								
21		IDLE		IDLE		CCCH		IDLE
22		IDLE		IDLE		CCCH		IDLE
23		IDLE		IDLE		CCCH		IDLE
24		IDLE		IDLE		CCCH		IDLE
25	IDLE					FCCH	IDLE	
26								
27								
28								
29								
30								
31								
32								
33								
34		IDLE		IDLE		CCCH		IDLE
35		IDLE		IDLE		CCCH		IDLE
36		IDLE		IDLE		CCCH		IDLE
37		IDLE		IDLE		CCCH		IDLE
38	PTCCH							
39								
40								
41								
42								
43								
44								
45								
46								
47		IDLE		IDLE		CCCH		IDLE
48		IDLE		IDLE		CCCH		IDLE
49		IDLE		IDLE		CCCH		IDLE
50		IDLE		IDLE		CCCH		IDLE
51	IDLE					SCH	IDLE	

FIG 4D

CARRIER 1

TS FRAME	0	1	2	3	4	5	6	7
0		BCCH		IDLE		IDLE		IDLE
1		BCCH		IDLE		IDLE		IDLE
2		BCCH		IDLE		IDLE		IDLE
3		BCCH		IDLE		IDLE		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12			PTCCH					
13								
14								
15								
16								
17								
18								
19								
20								
21		IDLE		IDLE		IDLE		CCCH
22		IDLE		IDLE		IDLE		CCCH
23		IDLE		IDLE		IDLE		CCCH
24		IDLE		IDLE		IDLE		CCCH
25	IDLE							FCCH
26								
27								
28								
29								
30								
31								
32								
33								
34		IDLE		IDLE		IDLE		CCCH
35		IDLE		IDLE		IDLE		CCCH
36		IDLE		IDLE		IDLE		CCCH
37		IDLE		IDLE		IDLE		CCCH
38	PTCCH							
39								
40								
41								
42								
43								
44								
45								
46								
47		IDLE		IDLE		IDLE		CCCH
48		IDLE		IDLE		IDLE		CCCH
49		IDLE		IDLE		IDLE		CCCH
50		IDLE		IDLE		IDLE		CCCH
51	IDLE							SCH
0		BCCH		IDLE		IDLE		IDLE
1		BCCH		IDLE		IDLE		IDLE
2		BCCH		IDLE		IDLE		IDLE
3		BCCH		IDLE		IDLE		IDLE
4								
5								

FIG 5A

CARRIER 2

TS FRAME	0	1	2	3	4	5	6	7
0		IDLE		BCCH		IDLE		IDLE
1		IDLE		BCCH		IDLE		IDLE
2		IDLE		BCCH		IDLE		IDLE
3		IDLE		BCCH		IDLE		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12			PTCCH					
13								
14								
15								
16								
17								
18								
19								
20								
21		CCCH		IDLE		IDLE		IDLE
22		CCCH		IDLE		IDLE		IDLE
23		CCCH		IDLE		IDLE		IDLE
24		CCCH		IDLE		IDLE		IDLE
25		FCCH	IDLE					
26								
27								
28								
29								
30								
31								
32								
33								
34		CCCH		IDLE		IDLE		IDLE
35		CCCH		IDLE		IDLE		IDLE
36		CCCH		IDLE		IDLE		IDLE
37		CCCH		IDLE		IDLE		IDLE
38	PTCCH							
39								
40								
41								
42								
43								
44								
45								
46								
47		CCCH		IDLE		IDLE		IDLE
48		CCCH		IDLE		IDLE		IDLE
49		CCCH		IDLE		IDLE		IDLE
50		CCCH		IDLE		IDLE		IDLE
51		SCH	IDLE					
0		IDLE		BCCH		IDLE		IDLE
1		IDLE		BCCH		IDLE		IDLE
2		IDLE		BCCH		IDLE		IDLE
3		IDLE		BCCH		IDLE		IDLE
4								
5								

FIG 5B

CARRIER 3

TS FRAME	0	1	2	3	4	5	6	7
0		IDLE		IDLE		BCCH		IDLE
1		IDLE		IDLE		BCCH		IDLE
2		IDLE		IDLE		BCCH		IDLE
3		IDLE		IDLE		BCCH		IDLE
4								
5								
6								
7								
8								
9								
10								
11								
12				PTCCH				
13								
14								
15								
16								
17								
18								
19								
20								
21		IDLE		CCCH		IDLE		IDLE
22		IDLE		CCCH		IDLE		IDLE
23		IDLE		CCCH		IDLE		IDLE
24		IDLE		CCCH		IDLE		IDLE
25		IDLE		FCCH		IDLE		
26								
27								
28								
29								
30								
31								
32								
33								
34		IDLE		CCCH		IDLE		IDLE
35		IDLE		CCCH		IDLE		IDLE
36		IDLE		CCCH		IDLE		IDLE
37		IDLE		CCCH		IDLE		IDLE
38					PTCCH			
39								
40								
41								
42								
43								
44								
45								
46								
47		IDLE		CCCH		IDLE		IDLE
48		IDLE		CCCH		IDLE		IDLE
49		IDLE		CCCH		IDLE		IDLE
50		IDLE		CCCH		IDLE		IDLE
51		IDLE		SCH		IDLE		
0		IDLE		IDLE		BCCH		IDLE
1		IDLE		IDLE		BCCH		IDLE
2		IDLE		IDLE		BCCH		IDLE
3		IDLE		IDLE		BCCH		IDLE
4								
5								

FIG. 5C

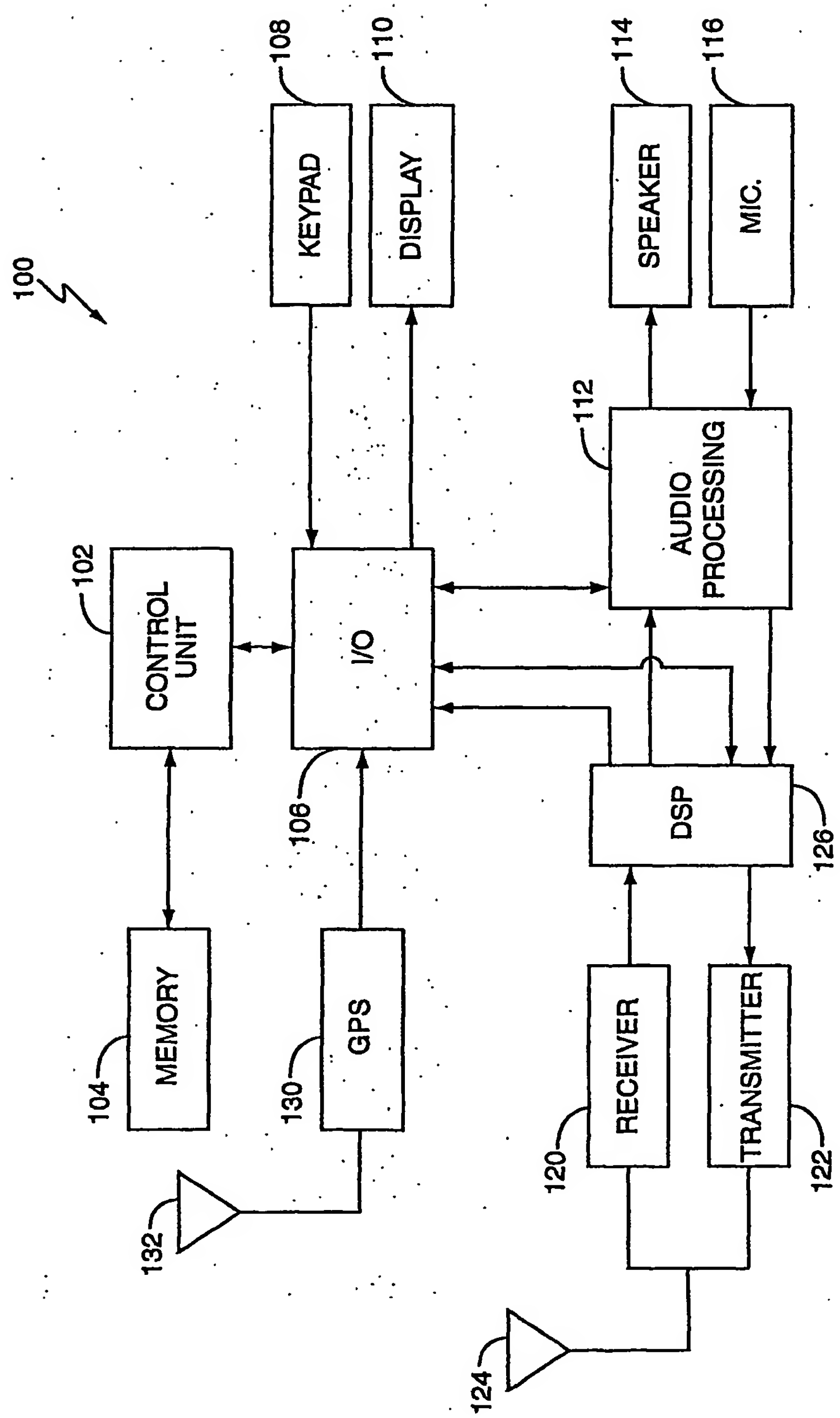
100
KEYPAD
108
DISPLAY
110
SPEAKER
114
MIC.
116
CONTROL UNIT
102
I/O
106
AUDIO PROCESSING
112
DSP
126
MEMORY
104
GPS
130
132
RECEIVER
120
TRANSMITTER
122
124

FIG. 6

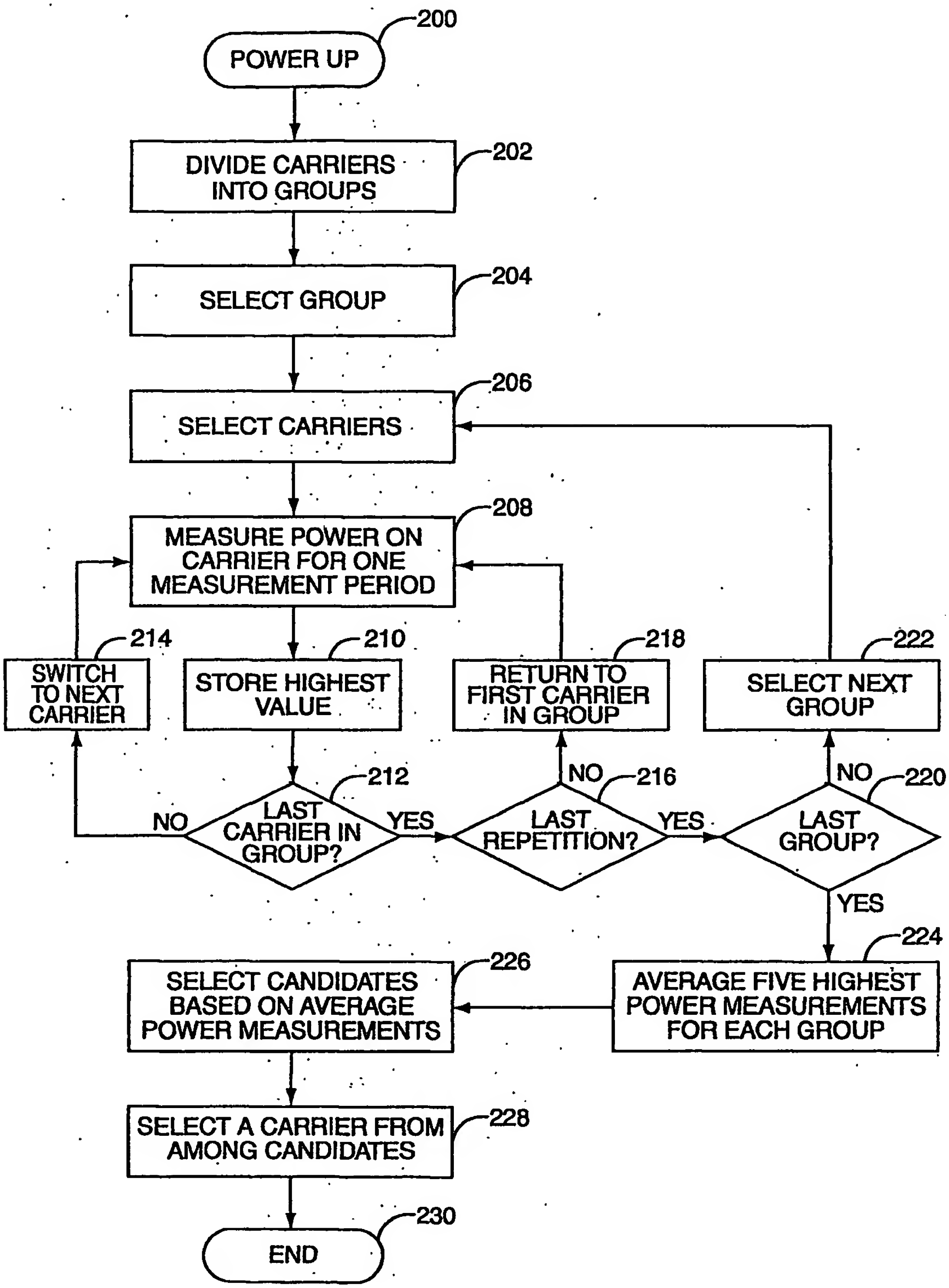
200
POWER UP
202
DIVIDE CARRIERS INTO GROUPS
204
SELECT GROUP
206
SELECT CARRIERS
208
MEASURE POWER ON CARRIER FOR ONE MEASUREMENT PERIOD
214
SWITCH TO NEXT CARRIER
210
STORE HIGHEST VALUE
218
RETURN TO FIRST CARRIER IN GROUP
222
SELECT NEXT GROUP
212
LAST CARRIER IN GROUP?
NO
YES
216
LAST REPETITION?
NO
YES
220
LAST GROUP?
NO
YES
224
AVERAGE FIVE HIGHEST POWER MEASUREMENTS FOR EACH GROUP
226
SELECT CANDIDATES BASED ON AVERAGE POWER MEASUREMENTS
228
SELECT A CARRIER FROM AMONG CANDIDATES
230
END

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/30283

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 468 569 A (PHILIPS ELECTRONICS UK LTD ;KONINKL PHILIPS ELECTRONICS NV (NL)) 29 January 1992 (1992-01-29) column 4, line 25 - line 29 column 4, line 43 - line 48 column 5, line 22 - line 25	1,2
A	EP 0 877 510 A (NOKIA MOBILE PHONES LTD) 11 November 1998 (1998-11-11) abstract	1

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 May 2001	07/06/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Leouffre, M

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PIRHONEN R ET AL: "TDMA BASED PACKET DATA SYSTEM STANDARD AND DEPLOYMENT" HOUSTON, TX, MAY 16 - 20, 1999, NEW YORK, NY: IEEE, US, vol. CONF. 49, 16 May 1999 (1999-05-16), pages 743-747, XP000941454 ISBN: 0-7803-5566-0 the whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/30283

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